of it as a dark spot. III and IV transit as dark or black spots, more frequently than would be supposed.

The following were the observations of the satellite as it left the planet:

Internal contact......7^h 19^m 21^s Mt. Hamilton m. t.
One-half off.........7 21   5   "   "   "
External contact......7 25 55   "   "   "

According to American Ephemeris, the egress should have been at 7^h 26.7^m, Mt. Hamilton m. t.   E. E. B.

Mt. Hamilton, Sept. 3, 1890.

Dark Transits of *Jupiter's* First Satellite.

A dark transit of *Jupiter's* first satellite occurred on the evening of August 23d. As this was a public night at the Observatory, it was not possible to observe the phenomenon properly; but from such views as were obtained from time to time with the thirty-six-inch equatorial, the satellite, which near the limb of *Jupiter* appeared as a bright white spot, reached equality of brightness with the surface of the planet at about one-fifth of its path on the disc from the limb, and near the center of the disc appeared as a round pale, grayish spot. At egress the order of appearances was reversed.

The satellite traversed the northern half of the white equatorial zone. Its shadow, which was projected on the same belt, was perfectly black.

Almost the same phenomena were observed in the transit of the first satellite on August 30th.   J. E. K.

A Possible Explanation of the Dark Transits of the Satellites of *Jupiter*.

The phenomena presented by the dark transits of *Jupiter's* satellites are among the most puzzling in the solar system, and any explanation which does not do violence to known natural laws, and is within the bounds of ordinary probability, must be regarded as entitled to some amount of consideration. It is from this standpoint that I wish to present the following as, at least, a possible explanation.

The principal facts to be accounted for are these:

1. In ordinary transits, the satellite is bright when projected upon the surface of *Jupiter* near the limb, and is usually lost sight of when it reaches the central parts of the disc.

2. Occasionally the satellite appears darker than the surface of *Jupiter* when in transit, even when projected on the brightest parts

of the disc, and the depth of shade may be very considerable, as a satellite has often been mistaken for its shadow. On leaving the disc, the satellite nevertheless appears quite bright when projected against the sky.

3. Dark transits of satellites increase in frequency with the order of distance from the primary, being more common for the outer satellites than for the inner ones.

4. The phenomena are irregular in occurrence, and therefore not predictable.

It is now generally held that the body of *Jupiter* is still intensely heated, possibly to a point approaching self-luminosity. Almost all observed facts support this view. An argument which has been made against it,—that the greatest activity of *Jupiter* is manifested in the regions which are most exposed to solar radiations,—is not entitled to any weight, since the sun itself, which does not derive its heat from external sources, exhibits the same excess of activity in the vicinity of the equator. Accepting then this view as to the constitution of *Jupiter*, there must be a considerable heat radiation from the planet, which doubtless affects, to a greater or less extent, the physical conditions of the satellites.

When a satellite is projected upon the central portion of *Jupiter's* disc, it is usually invisible. This indicates an albedo which is surprising in a small non-luminous body, and points to an unusual condition of things on its surface.

Let us now suppose what is certainly extremely probable, that the satellite is a cold, hard body with an albedo not greater than that of ordinary rock; and further, what is by no means impossible, that the satellites are surrounded by atmospheres containing large quantities of aqueous vapor. In support of the last supposition, may be mentioned the spectroscopic observations of VOGEL, who saw traces of the great absorption band which characterizes the spectrum of *Jupiter* in the spectra of the satellites.* Then the water which, in the absence of internal heat, and at the great distance of the satellite from the sun, would, under other circumstances, be frozen, and remain fixed upon the surface, would be vaporized by the heat radiated from the central planet. Hence, we should have the satellite surrounded by clouds in the same manner as *Jupiter* itself, and the albedos of the two bodies would be equal. It would seem that, considering the extreme tenuity of the atmosphere which so small a

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* I have not been able to satisfactorily verify this observation myself.

body would possess, the amount of heat required for the existence of such conditions is not in excess of the supply which we may well suppose to be actually afforded by the planet.

In the case of the outer satellites especially, we can, however, readily conceive that the heating effect of the planet is barely sufficient to overcome the cold of space. The cloud layers are, therefore, in unstable equilibrium, and at any moment some accidental disturbance would determine a general precipitation on the side farthest from the source of heat, thereby reducing the albedo of the satellite from its greatest value, that of pure white clouds, to a much lower one, which would have as its minimum that of the surface of the satellite itself. If at such a time the satellite should be projected on the disc of *Jupiter*, we should have the phenomenon of a dark transit. Such transits would evidently be characterized by an irregularity which is actually a feature of their occurrence.

The brightness of the satellite after it has left the disc is not surprising, when we consider how difficult it is to judge of the relative brightness of two surfaces which are not actually in contact. It is quite likely that a very considerable difference could exist under the circumstances of a transit without attracting notice. It might, however, be detected by careful photometric comparisons immediately after the satellite had passed off the disc.

If the satellites should be found to rotate in such a manner as always to present the same side to *Jupiter*, the explanation here suggested might require modification, although it would not necessarily be false. It will probably be conceded, however, that the evidence of such a law of rotation is at present very slight.   J. E. K.

On the Explanation of the Dark Transits of *Jupiter's* Satellites.

The recent numbers of the *Publications A. S. P.* have had articles by Messrs. KEELER, BARNARD and HILL on the dark transits of *Jupiter's* satellites. These articles refer both to observations and to possible explanations of the phenomena. It appears to me that the simplest way of accounting for these is somewhat as follows:

The albedo of *Jupiter* is 0.62, and the albedos of the satellites are, respectively: I, 0.22; II, 0.27; III, 0.14; IV, 0.08.

For our purposes we may define

$$\text{albedo} = \frac{\text{light reflected per unit-area}}{\text{light received per unit-area}}.$$